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Original article

The incidence of clinical fractures in adults aged 50 years and older in Spain

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Abstract

Objective. The aim of this study was to quantify the incidence of all clinical fractures, including traumatic and fragility fractures, in patients aged 50 years and older, and to describe their distribution by fracture location, sex and age.

Methods. The incidence of clinical fractures at 10 hospitals in Catalonia, with a reference population of 3 155 000 inhabitants, was studied. For 1 week, from 30 May to 5 June 2016, we reviewed the discharge reports of the Traumatology section of the Emergency Department to identify all fractures diagnosed in patients $\geq$50 years of age. As a validation technique, data collection was carried out for 1 year at one of the centres, from 1 December 2015 to 30 November 2016. The fracture incidence, including the 95% CI, was estimated for the entire sample and grouped by fracture type, location, sex and age.

Results. A total of 283 fractures were identified. Seventy per cent were in women, with a mean age of 72 years. The overall fracture incidence was 11.28 per 1000 person-years (95% CI: 11.10, 11.46), with an incidence of traumatic and fragility fractures of 4.15 (95% CI: 4.04, 4.26) and 7.13 per 1000 person-years (95% CI: 6.99, 7.28), respectively. The incidence of fractures observed in the validation sample coincided with that estimated for the whole of Catalonia. The most common fragility fractures were of the hip, forearm, humerus and vertebrae.

Conclusion. The results of this study are the first to estimate the incidence of clinical fragility fractures in Spain, grouped by location, age and sex.

Key words: fracture incidence, fragility fracture, traumatic fracture

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CLINICAL SCIENCE

Key messages

- The incidence of fractures, apart from hip fractures, is unknown in most countries.
- We describe the incidence of fragility and traumatic vertebral and non-vertebral fractures in Spain.
- Seven out of 1000 people have a fragility fracture every year in Spain.

Introduction

Osteoporosis is related to >8.9 million fractures per year worldwide, equivalent to one every 3 s. More than one-third of all fractures occur in Europe [1]. In 2002, the disease burden of fragility fractures in Europe was compared with the burden caused by other diseases, and fragility fractures were found to have the highest disease burden after ischaemic heart disease, chronic obstructive pulmonary disease, OA, Alzheimer's disease and cirrhosis. When compared with the disease burden of specific types of cancers, only that caused by lung cancer was higher [1].

The most common fragility fractures are of the hip, spine, wrist and humerus; so-called major fractures. Hip fractures are of particular concern because they require surgery and can lead to a loss of independence or an exponentially increased risk of death. The incidence of hip fractures is heterogeneous in different regions and countries, as is likely to be the incidence of other fragility fractures [2]. The incidence of hip fractures is well known because all patients are admitted to the hospital, requiring their diagnosis to be coded and registered at discharge.

Vertebral fractures can cause intense acute back pain for weeks or even months and lead to serious long-term consequences, including height loss, thoracic deformity, restrictive respiratory disorders and death. However, the incidence of vertebral fractures is less known because of their specific characteristics. Highly symptomatic fractures are admitted for pain control, but these are a small proportion of all of them. It is estimated that approximately one-third of vertebral fractures are asymptomatic and undiagnosed. Even in the case of symptomatic vertebral fractures that do not require a hospital admission, many are not diagnosed if a spine X-ray is not indicated.

The incidence of all other non-hip, non-vertebral fragility fractures cannot be calculated easily during systematic data collection for cohort studies, because their codes are not registered. Patients consult the Emergency Department for the fracture; the fracture is treated with a cast, and the patient is discharged. Coding is optional and left up to the primary care physician. Even if the fractures are coded, their mechanism of injury, such as traumatic *vs* fragility, is not. The real incidence of fragility fractures worldwide is, therefore, mostly unknown. There is general agreement in the scientific community that the best incidence data on other fragility fractures comes from Malmö and from Olmsted County, Rochester, MN, USA [3, 4].

Knowing the incidence of fractures is necessary to estimate the health resources needed for their management. Even more importantly, knowing the incidence of fractures allows us to calculate the size of public health strategies dedicated to the prevention of new fractures. This includes Fracture Liaison Services that are designed in accordance with the objectives of the Capture the Fracture campaign of the International Osteoporosis Foundation to solve the treatment gap in patients who sustain fragility fractures. We designed a study to quantify the incidence of both traumatic and fragility clinical fractures in patients ≥50 years of age and to describe their distribution by fracture location, sex and age.

Methods

Design of the study

The research team was composed of rheumatologists who belonged to the Osteoporosis Working Group of the Catalonian Society for Rheumatology (OsCat) and included collaborators who were also interested in the study of osteoporosis and fragility fractures. The final list of participating centres included 10 hospitals in Catalonia with a reference population of 3 155 000 inhabitants, which represents nearly 50% of the Catalan population (7 424 754 inhabitants in 2015).

For 1 week, from 30 May to 5 June 2016, participating researchers reviewed the discharge reports of patients seen in the Traumatology section of the Emergency Department of the centres to identify all clinical fractures diagnosed in patients ≥50 years of age from the reference population of each hospital.

Definitions

Fractures were classified into traumatic and fragility fractures.

Fragility fractures were defined as those that occurred during an activity that would normally not harm healthy young bone, such as when the most likely cause of injury was a low-impact trauma or a fall from a height corresponding to a standing position.

Fractures were recorded as traumatic when the most likely cause of injury was severe trauma. Fractures in some anatomical locations were directly assigned to the traumatic injury group: patella, carpus, metacarpus, fingers, tarsus, metatarsus and toes. Other recorded anatomical locations included vertebrae, scapula, clavicle, sternum, ribs, humerus, elbow, radio, ulna, forearm, sacrum, pelvis, hip, femur, tibia, fibula and ankle.

We excluded pathological fractures.

Variables

In patients with fragility fractures, the study variables collected included: (a) fracture risk factors included in FRAX, i.e. BMI, a history of a previous fracture, a history of parental hip fracture, current smoking status, a history of RA, oral glucocorticoid use for >3 months at a dose ≥5 mg of prednisolone, daily intake of ≥3 units of alcohol, age at menopause and secondary osteoporosis; (b) other fracture risk factors, such as the number of falls in the last year and some of their determinants (walking autonomy, physical exercise and going outside); and (c) dietary calcium intake.

In traumatic fractures, only age, sex and fracture location were recorded, because these are the only data available in the discharge report.

Study protocol

Data collection from admitted patients was performed during their hospital stay. These patients were given the study information sheet and, after a discussion, their written consent was obtained for them to participate in the study.

Outpatient data were retrieved from their discharge report, hospital history and computerized primary care history and were completed by telephone. During this telephone call, patients were informed of the objectives of the study and their oral consent was obtained.

In cases where the fracture mechanism was unclear from the discharge report, the patient was contacted by telephone for clarification.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Each patient was anonymized using a patient code, and only the researchers at each centre had access to the personal data of the patients included in their centre. The processing, communication and transfer of the persona data of all participating subjects were in accordance with Spanish laws on the protection of personal data.

The study was approved by the Clinical Research Ethics Committee of the Hospital Universitari de Bellvitge (HUB) as the reference centre and in all the participating centres, in accordance with current Spanish legislation.

Statistics

The weekly fracture incidence was estimated for the entire sample and grouped by fracture type, sex and age (50–59, 60–69, 70–79 and ≥ 80 years). Point estimates were accompanied by a 95% CI using the asymptotic approximation of a binomial distribution in a normal distribution. To estimate the annual fracture incidence, the weekly fracture incidence was multiplied by 52.18 (number of weeks per year). It was assumed that there was no seasonal or territorial variability in fracture incidence, although a higher incidence of hip fractures has been described in winter [5, 6].

To estimate the incidence denominator, it was assumed that the reference population of the included centres (3 155 000 inhabitants) was distributed, with respect to age and sex, in the same way as the whole population (7 424 754 inhabitants). Municipal registry data from 2015 provided by the Official Catalan statistics institute (IDESCAT) were used to calculate the age and sex distribution of the study population of the participating centres (Supplementary Table S1, available at *Rheumatology Advances in Practice* online).

As an example, for women between 50 and 59 years, the total number of Catalan women was 508 142 in 2015, and the proportional number of the reference population 238 778. Assuming we had identified 100 fractures in this age and sex group in a week, that would result in 5218 fractures in a year (100×52.18), 0.02185 fractures per person and year (5218/238 778) and 21.85 per 1000 person-years.

In one of the participating centres, HUB, which has a Fracture Liaison Service, data collection was carried out over a 1-year period, from 1 December 2015 to 30 November 2016. The annual incidence rates observed at this centre were calculated and compared with the estimated annual incidence rates of the whole population, for validation purposes. The 95% CIs of the annual incidence observed at HUB and the estimated annual incidence were expected to overlap. For analysis and data management, R v.3.3.3 (R Foundation for Statistical Computing) for Windows was used.

Results

During the observation week, a total of 283 clinical fractures of an equal number of patients from the reference population were identified. Seventy per cent were women, and the mean age was 72 years (Table 1). Of these, about half of all fragility fractures and three-quarters of all major fractures were identified in the age group of ≥80 years. Fractures were more frequent among women overall, but the difference between sexes was more prominent in the incidence of fragility fractures. The mean (S.D.) age of patients with fragility fractures was higher than that of those with traumatic fractures [75.38 (13.86) *vs* 67.00 (11.69) years, respectively; $P < 0.05$].

The overall fracture incidence was 11.28 per 1000 person-years (95% CI: 11.10, 11.46), with an incidence of traumatic and fragility fractures measured at 4.15 (95% CI: 4.04, 4.26) and 7.13 per 1000 person-years (95% CI: 6.99, 7.28), respectively. Fracture incidence grouped by type and location is shown in Table 2. The accumulated fracture incidence by age and sex for traumatic and fragility fractures is shown in Fig. 1.

With respect to location, the most common traumatic fractures were those of the toes and fingers, with respective incidence rates of 1.25 (95% CI: 1.17, 1.34) and 0.89 per 1000 person-years (95% CI: 0.82, 0.97). The incidence of traumatic fractures decreased with age in men, from 3.8 per 1000 person-years in the

Table 1 Demographics

	All fractures		Traumatic fractures		Fragility fractures	
	n (%)[a]	Age, years, mean (s.d.)	*n* (%)[a]	Age, years, mean (s.d.)	*n* (%)[a]	Age, years, mean (s.d.)
All	283 (100)	72.42 (13.71)	104 (37)	67.00 (11.69)	179 (63)	75.38 (13.86)
Women	199 (72)	74.06 (13.35)	57 (57)	69.42 (11.91)	142 (79)	75.86 (13.49)
Men	79 (28)	68.66 (13.92)	43 (43)	63.92 (10.85)	36 (21)	74.07 (15.16)

[a]Number of fractures recorded in 1 week.

Table 2 Clinical fracture incidence grouped by type and location

Fracture incidence	All fractures		Traumatic fractures		Fragility fractures	
	n[a]	AI[b] (95% CI)	*n*[a]	AI[b] (95% CI)	*n*[a]	AI[b] (95% CI)
All fractures	283	11.28 (11.10, 11.46)	104	4.15 ([4.04, 4.26)	179	7.13 (6.99, 7.28)
Major fractures[c]	146	5.82 (5.69, 5.95)	18	0.72 (0.67, 0.77)	128	5.1 (4.98, 5.23)
Hip	50	1.99 (1.92, 2.07)	1	–	49	1.95 (1.88, 2.03)
Forearm	43	1.71 (1.64, 1.79)	6	–	37	1.47 (1.41, 1.54)
Humerus	33	1.32 (1.25, 1.38)	5	–	28	1.12 (1.06, 1.18)
Vertebral fractures	20	0.8 (0.75, 0.85)	6	–	14	0.56 (0.52, 0.60)

[a]Number of fractures recorded in 1 week. [b]Accumulated incidence estimated for 1000 person-years. [c]Hip, forearm, humerus and vertebral fractures.

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50–59 year age group to 2.8 per 1000 person-years among those $\geq$ 80 years. In women, there was a slight increase in the incidence of traumatic fractures, from 2.6 to 5.1 per 1000 person-years, respectively, in the 50–59 and $\geq$ 80 year groups (Fig. 1A).

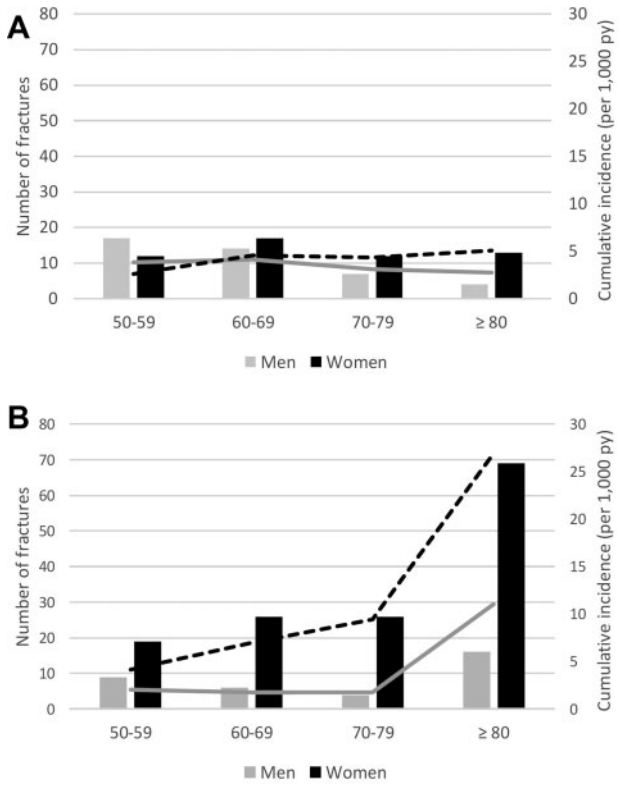
The most common fragility fractures, in order, were of the hip, forearm, humerus and vertebrae. The incidence of hip fractures was 2.82 per 1000 person-years (95% CI: 2.69, 2.95) in women and 1.06 per 1000 person-years (95% CI: 0.98, 1.14) in men (Table 3). In women, the incidence of distal forearm fractures nearly coincided with that of the hip [2.50 per 1000 person-years (95% CI: 2.38, 2.63)]. In Figs 1B and 2A–D, we show that the incidence of fragility fractures increased exponentially with age in both sexes, always with a higher rate among women. Table 4 describes the main fracture risk factors of the patients who suffered a clinical fragility fracture.

In the HUB sample, which included a 1-year observation period, a total of 920 fractures of an equal number of patients were recorded. Seventy-three per cent were women, and the average age was 73 years. Of these, 25% were <65 years, and another 25% were between 83 and 103 years of age. The fracture incidence observed in the HUB validation sample (Supplementary Table S2, available at *Rheumatology Advances in Practice* online) coincided with that estimated for the whole of Catalonia, except in the case of vertebral fractures. The incidence of vertebral fragility fractures observed in the HUB per year was 1.58 per 1000 person-years (95% CI: 1.31, 1.90), whereas that estimated in the 10-hospital sample was 0.56 per 1000 person-years (95% CI: 0.52, 0.60). This underestimate impacted the overall major fracture incidence, whereby a slight underestimation was observed in the 10-hospital sample [5.1 (95% CI: 4.98, 5.23) *vs* 6.42 person-years (95% CI: 5.86, 7.02)]. This difference is attributable to differences in the way vertebral fractures were diagnosed in both settings. The HUB, apart from the vertebral fractures detected in the Emergency Department, also included clinical and radiological vertebral fractures referred to its Fracture Liaison Service by primary and specialized care physicians.

Discussion

The results of this study provide an estimate of the incidence of clinical fragility fractures in Spain, grouped by location, age and sex, for the first time. In the population of Catalonia aged $\geq$50 years, the incidence of fragility fractures was 7.13 per 1000 person-years and the incidence of major fractures was 5.1 per 1000 person-years. As expected, the incidence of fractures was higher in women and increased with age. These data confirm that

Fig 1 Clinical fracture incidence by age and sex



The bars correspond to the number of fractures estimated in 1 year (left vertical axis), and the lines correspond to the estimated fracture incidence per 1000 person-years (py; right vertical axis). Panel A shows the data for traumatic fractures. Panel B shows the data for fragility fractures.

Table 3 Clinical fragility fracture incidence grouped by sex and location

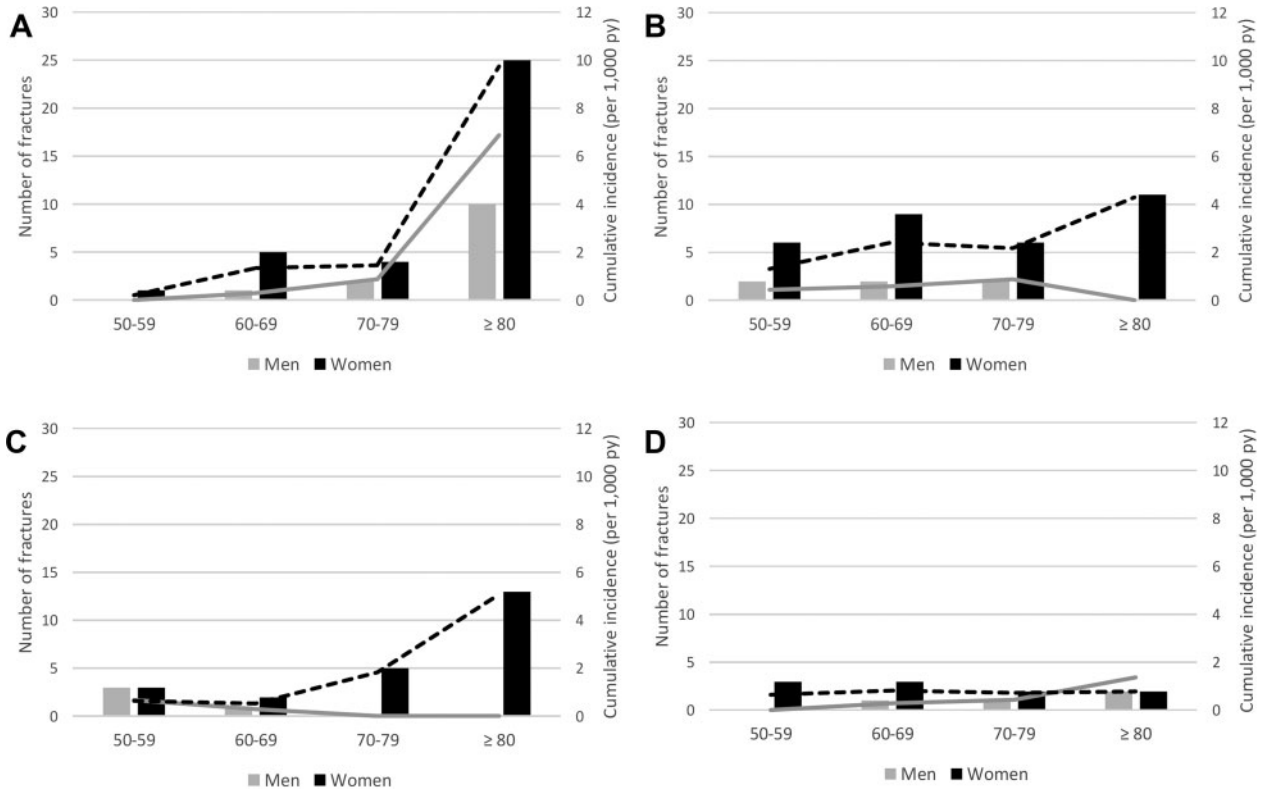
Fracture incidence	All fragility fractures		Women		Men	
	n[a]	AI[b] (95% CI)	*n*[a]	AI[b] (95% CI)	*n*[a]	AI[b] (95% CI)
All fractures	179	7.13 (6.99, 7.28)	142	10.46 (10.23, 10.70)	37	3.13 (2.99, 3.27)
Major fractures[c]	128	5.1 (4.98, 5.23)	102	7.62 (7.32, 7.72)	26	2.17 (2.05, 2.29)
Hip	49	1.95 (1.88, 2.03)	36	2.65 (2.54, 2.78)	13	1.13 (1.05, 2.22)
Forearm	37	1.47 (1.41, 1.54)	32	2.36 (2.25, 2.47)	5	0.43 (0.38, 0.49)
Humerus	28	1.12 (1.06, 1.18)	24	1.77 (1.67, 1.87)	4	0.26 (0.22, 0.31)
Vertebral fractures	14	0.56 (0.52, 0.60)	10	0.74 (0.68, 0.80)	4	0.35 (0.3, 0.4)

[a]Number of fractures recorded in 1 week. [b]Accumulated incidence estimated for 1000 person-years. [c]Hip, forearm, humerus and vertebral fractures.

Spain overall has a medium risk of fractures when compared with the UK, which has a high risk, or Sweden, which has a very high risk of fractures. Age-standardized hip fracture rates had been estimated as 2.28, 3.49 and 5.39 per 1000 person-years in women from Spain, the UK and Sweden, respectively [2–4]. According to Spanish estimates, in our study, the incidence of hip fracture was 2.65 per 1000 person-years.

In Catalonia, the approximate incidence of outpatient fractures was based on data from the SIDIAP database (Information System for the Development of Research in Primary Care), which contains clinical information from computerized primary care records [7]. In a sample of 2 011 430 patients aged ≥50 years, a retrospective cohort study identified fractures that occurred in 2009. Fracture rates were 10.91 per 1000 person-years (15.18

Fig. 2 Clinical fragility fracture incidence by age and sex



The bars correspond to the number of fractures estimated in 1 year (left vertical axis), and the lines correspond to the estimated fracture incidence per 1000 person-years (right vertical axis). Panels show the data for hip (**A**), forearm (**B**), humerus (**C**) and vertebral (**D**) fractures.

per 1000 person-years in females and 5.78 per 1000 person-years in males). The authors did not have sufficient information to provide data specific to fragility fractures. Considering all fractures, the incidence of fractures in SIDIAP database is similar to ours.

The incidence of distal forearm fractures in Zaragoza, located with Catalonia in the northeast of Spain, was evaluated retrospectively over a 2-year period (1998–1999) for patients >15 years of age [8]. A total of 2506 distal radius fractures were registered: 868 in men (34.6%) and 1638 in women (65.4%). A low-energy mechanism of injury was recorded in 78.2% of cases, whereas 21.8% were high-energy impacts. The total fracture incidence was 3.06 per 1000 person-years. The incidence of fractures in women was 3.8 per 1000 person-years, compared with 2.23 per 1000 person-years in men. The fracture incidence in women >70 years of age was 12.0 per 1000 person-years. These rates are higher than those calculated in our study, mainly in older women. The overall difference might be explained by the age range included. In older women, what draws attention is the high incidence found in Zaragoza, because it is accepted that there is no increase in forearm fractures with age in either men or women [4].

Additional work performed as a follow-up to a prevalence study of vertebral fractures (the EVOS Study) [9] used three postal questionnaires over a 6-year period to evaluate the incidence of vertebral and other osteoporotic fractures in a cohort of 624 men and women >50 years of age from the local registry of Oviedo (in the north of Spain) in 1986 [10]. They identified 57 fractures, with a resultant incidence of 2.36 per 1000 person-years for hip fractures, 4.77 per 1000 person-years for distal forearm fractures, 9.85 per 1000 person-years for vertebral fractures and 5.80 per 1000 person-years for other fragility fractures. These rates are also higher than those in our study, but the main difference is in the distribution of the fracture locations. They identified 7 hip fractures and 14 forearm fractures, whereas a similar number of each would be expected [3].

The ECOSAP study was performed throughout Spain [11], included 5201 women aged ≥65 years, and focused only on hip, humerus and forearm fragility fractures throughout a 3-year period. The resulting overall incidence of non-spine fractures in women was 24.20 per 1000 person-years. The incidence rates of forearm, hip and humeral fractures were 8.87, 3.69 and 3.33 per 1000 person-years, respectively. Again, the rates are higher but the difference in this case is surely attributable

TABLE 4 The main risk factors of patients who suffered a clinical fragility fracture

Risk factor	
Age, years, mean (S.D.)	75.38 (13.86)
Sex, *n* (%)	
Women	143 (79)
Men	36 (21)
BMI, kg/m^2	
Mean (S.D.)	26.61 (4.80)
Median (interquartile range)	26.33 (23.48–29.26)
Patients with BMI $<$ 20 kg/m^2, *n* (%)	10 (5.99)
Previous fragility fracture, *n* (%)	49 (27.37)
Parent fractured hip, *n* (%)	19 (12.34)
Current smoking, *n* (%)	21 (12.8)
RA, *n* (%)	5 (2.98)
Oral glucocorticoids $>$3 months at a dose of $\geq$ 5 mg prednisolone, *n* (%)	18 (10.78)
Intake of $\geq$3 units of alcohol daily, *n* (%)	12 (7.69)
Age at menopause, years	
Mean (S.D.)	48.39 (4.81)
Median (IQR)	50.00 (46.25–51.75)
Premature menopause ($<$45 years), *n* (%)	15 (10.79)
Secondary osteoporosis, *n* (%)	24 (16.11)
Number of falls in the last year, *n* (%)	
One	189 (66.78)
More than one	94 (33.22)
Walking autonomy, *n* (%)	
Autonomous	103 (63.98)
One support	32 (19.88)
Two supports	21 (13.04)
Wheelchair	5 (3.11)
Do not perform any physical exercise, *n* (%)	102 (64.15)
Never go outside, *n* (%)	21 (12.96)
Dietary calcium intake, mg	
Mean (S.D.)	482.72 (249.27)
Median (interquartile range)	500.00 (300.00–600.00)

Category percentages are based on the total number of valid cases, with the exception of menopausal factors, which count only women.

to the age range included. In this age group, the high proportion of forearm fractures is even more remarkable.

In summary, the incidences of fragility hip fracture in the Oviedo and ECOSAP studies are similar to ours. The incidences of vertebral fractures cannot be compared, because in our study they are underestimated. What is remarkable is the higher incidences of distal forearm fractures in the Zaragoza, Oviedo and ECOSAP studies with respect to those found in our study and in the SIDIAP database. More extensive studies are needed to establish the incidence of vertebral and non-vertebral fragility fractures in Spain.

The study we have performed is the only one in Spain to have included fractures in all locations and to have differentiated between traumatic and fragility fractures. Some of our data are remarkable. We have identified that minor fractures, which are not predicted by FRAX, compose more than one-quarter of all fragility fractures. Although individually their number is low compared with major fractures, overall they should not be ignored in the planning of secondary fracture prevention.

Recent data confirm the previously described great variability in the incidence and tendency for hip fracture among the different Autonomous Communities in Spain [12, 13]. To extrapolate our data for major and total fractures to the whole of Spain, it would be necessary to estimate them from their ratio with hip fractures. Our data might be useful to estimate the health resources necessary to plan and implement adequate secondary prevention. Regarding costs, there are notable differences in the mean costs across Autonomous Communities in Spain, mainly caused by the differential duration of surgical delay and first hospital stay and the outpatient care in subsequent months [14].

The study has some limitations. First, the data collection period was only 1 week, which might seem short. This was our concern while planning this study. We had

to choose between extending the study period and including fewer study centres, reducing our reference population, because the participating researchers are clinicians with a large workload who could not dedicate more time to data collection. We decided that the reference population was large enough to perform the study but also introduced a mechanism to assure its internal validity, which was to replicate it in data from HUB obtained over a whole year. We now believe that the number of fractures identified and the similar results obtained from the 1-week and 1-year studies guarantee the validity of the fracture incidence we calculated. Additionally, the similar results obtained the study by Pagès-Castellà *et al.* [7] for all fractures provide additional external validity to our study.

We cannot rule out the possibility that some patients with fractures have gone to visit private hospitals in our area, a fact that would lead to an underestimation of the incidence of fractures. However, in our environment, the proportion of patients treated in private medicine is very low.

We have assumed no seasonal variation in fracture incidence to derive the annual fracture incidence from the weekly fracture incidence. A seasonal variation in hip fracture incidence has been described in Catalonia [5] and analysed thoroughly in Alcorcón, near Madrid [6], with a higher incidence in cold seasons. Non-hip, non-vertebral fractures seem not to be affected by weather conditions [15]. In fact, the incidence of hip fracture in HUB was higher than that calculated for the whole of Catalonia, whereas incidences of humerus and forearm fracture were similar. Regarding this point, we want to emphasize that the real value of our study is in providing data on the incidence of non-axial fractures, for which fewer data are available.

As a final limitation, we would like to highlight the difficulty in classifying a fracture mechanism as high or low impact and traumatic *vs* fragility. All participating researchers received the same written and face-to-face instructions on the classification criteria in order that they could perform this in a uniform way. However, we anticipate doubt in particular cases, even if the patients had fallen from a standing position, the classic definition of a fragility fracture. This is an inherent limitation to all fracture studies that is not preventable until we develop a valid and reliable decision aid to classify fractures into traumatic and fragility subgroups.

As a result of our work, we have provided data on clinical fracture incidence in Spain, including traumatic and fragility fractures in all locations. This information can be very useful in the planning of the health resources required for their management and in the secondary prevention of fragility fractures. Knowing the incidence of fragility fractures in the population reinforces the need to create Fracture Liaison Services throughout the territory and facilitates the planning of their location and their dimensions regarding human resources and physical space. We propose that this needs to become an objective of the health authorities.

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Disclosure statement: The authors have declared no conflicts of interest.

Data availability statement

The data underlying this article will be shared on reasonable request to the corresponding author.

Supplementary data

Supplementary data are available at *Rheumatology Advances in Practice* online.

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